INSTRUCTION MANUAL

NO. IN 1211.3-4.1

BARBER COLMAN

Capacitrols

model 403C

MP MASTER
MA32122

BARBER-COLMAN COMPANY
Industrial Instruments Division • Rockford, Ill., U.S.A.

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INSTRUCTION MANUAL — MODEL 403C INDICATING CONTROLLER

(This Instruction Manual also applies to the Model previously designated 403C-S372).

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NOTE: This instruction manual to be given to persons responsible for installation and maintenance of this instrument.

UNPACKING INSTRUMENT

This precision Instrument and its associated equipment have been carefully manufactured and packed at the factory. Remove the instrument and accessories from the packing box and check items against the packing slip. If the equipment is found to be damaged in transit, report extent of damage to the carrier immediately. Repack in original packing box until ready for installation.

CAUTION:

Handle with care.
Safeguard instrument from shock.
Avoid oil accumulation.
Keep instrument temperature under 130° F.

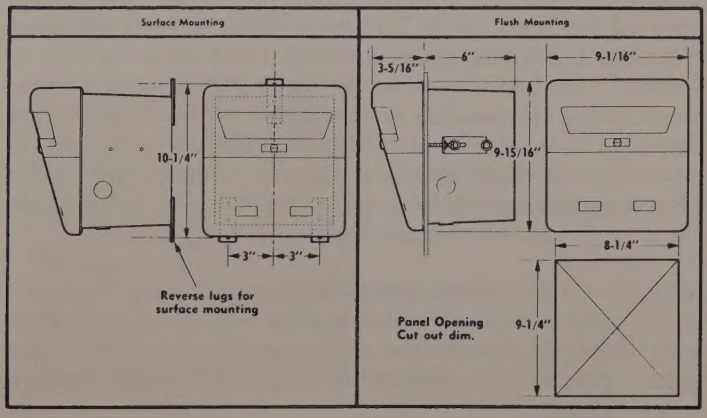
MOUNTING INSTRUCTIONS

Locate the instrument to avoid shock, excessive vibration, moisture and temperatures over 130° F. Avoid furnace walls, radiation of heat, machine frames and outside walls. Provide suitable shelter to avoid moisture and temperature extremes if installed outdoors.

For surface mounting, attach the three lugs (provided) to the back of the instrument housing. See the surface mounting dimension drawing.

For flush or panel mounting, remove the angle brackets from the cloth bag, insert the instrument through the panel opening, attach brackets to the side of the instrument housing and tighten firmly. See the flush mounting dimension drawing.

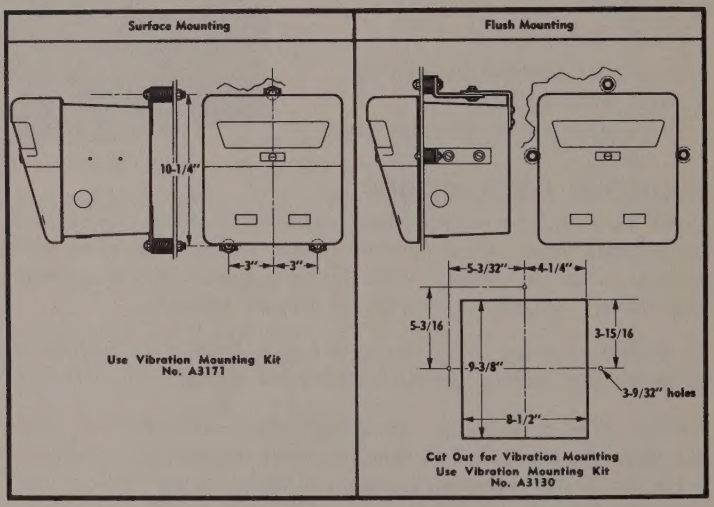
MOUNTING DIMENSIONS



Vibration mounting kits should be used if the vibration causes erratic temperature readings or control. See the vibration mounting dimension drawing for details of surface or flush mounting. Special provisions may have to be considered if the instrument is subjected to severe shock such as from a drop forge or similar type of equipment.

Moderate care should be taken to mount the instrument level.

MOUNTING DIMENSIONS
Vibration Mountings



POWER WIRING

Remove the lower section of the front cover to expose the terminal strips and the control chassis. To expedite wiring, grasp the side plates of the chassis and pull forward to remove. Check the rating plate on the side of the chassis for the supply voltage and frequency. Connect proper voltage and frequency to terminals L1 and L2. Supply voltage should be 110 to 130 volts AC or 220 to 260 volts AC or 208 volts AC depending on chassis specifications. Run all wiring in rigid conduit, BX or Greenfield, in accordance with the recommended electrical code. Use properly fused switches, see diagram.

Solid wire (14 ga.) is recommended for instrument wiring. If stranded wire is used, tin the ends to provide secure connections. Position the wires so they do not interfere with control chassis or the housing gaskets. Ground the instrument case; a grounded conduit system is usually sufficient.

THERMOCOUPLE WIRING

Do not run thermocouple lead wire with other power or control wiring except for thermocouple break (TCB) wires, if used. Several thermocouple lead wires may be run in the same conduit if desired.

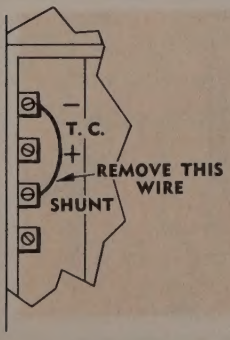
Use only extension lead wire correct for the type of thermocouple (TC) as specified on the scale. The most commonly used types are: Iron-Constantan (I/C or Type J), Chromel-Alumel (C/A or Type K), Platinum-Platinum 10% Rhodium (Pt/Pt 10% Rh or Type S), Platinum-Platinum 13% Rhodium (Pt/Pt 13% Rh or Type R), and Heat-Eye. Ordinary copper wire will NOT serve the purpose.

Proper polarity (+) and (—) of the lead wire must be observed to obtain correct readings. The negative wire is usually coded red. Correct polarity of the lead wire can be checked by heating a temporary junction of the lead wire far end. Deflection of the indicator upscale indicates correct polarity of the lead wire.

The thermocouple should then be connected to the lead wire and the indicating pointer should again deflect upscale when the thermocouple hot junction is heated. If the indicator moves downscale, reverse only the connections at the thermocouple head since the lead wire has already been correctly connected to the instrument.

Secure the lead wire firmly under the terminal screw head. If desired, spade lugs may be used. Locate the lead wire so it dos not interfere with the control chassis or housing gaskets.

METER SHUNT WIRE



After the instrument is installed, disconnect the jumper wire across terminals "Shunt" and "TC—". This wire is used to shunt or dampen the meter movement for protection during shipping, installation and handling of the instrument but should be removed for normal operation.

NOTE: Replace this shunt wire when handling or reshipping the instrument and position the red control point indicator to the top of the scale.

LINE COMPENSATOR RESISTOR (KIT NO. A-3497)

The external resistance, combined resistance of the extension lead wire and thermocouple, for which the meter has been calibrated is marked on the meter scale. Most meters are calibrated for 15 ohms (Ext. Res. 15 ohms) which is more resistance than most lead wire runs. The balance of the resistance, 15 ohms minus the actual external resistance, will be inserted on a removable resistance strip located just under the meter section. The resistance value is marked on the strip and is inserted at the time of the original order. Other values are available. However, lead wire length can be changed up to 25 ft. without appreciable error in reading because a high resistance movement is used.

Model 403C "Ext. Res. 15 + 10 ohms" compensates for the 10 ohms in the control chassis for the Capaciline circuit.

THERMOCOUPLE BREAK PROTECTION (TCB)

The instrument is equipped with thermocouple break (TCB) protection. Essentially it is a small DC voltage that can be wired into the thermocouple circuit to drive the movement upscale in case of an open circuit in the thermocouple, thus passing the control set point and causing the instrument control to go to the off position. It is not necessary to make the TCB connections for normal operation of the instrument, but its use may be desirable on some applications to guard against overheating in event of an open thermocouple.

The preferred method of connecting TCB is shown in Fig. 1. Use extension lead wire as required to make the connection between the instrument TC terminals and the thermocouple head. Use 14 gauge copper wire to connect the TCB terminals to the thermocouple head, observing polarity. Wiring for TCB may be run in the same conduit with thermo-

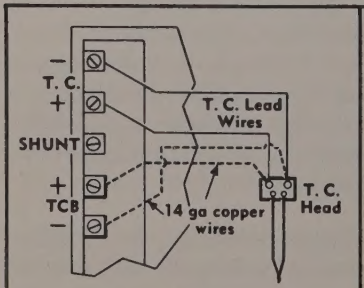


Fig. 1

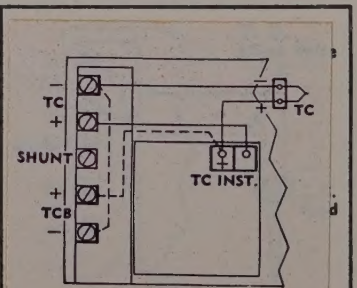


FIG. 2

couple lead wire. As the resistance of the thermocouple is low compared to the resistance of the meter movement, TCB compensation is seldom required.

The optional method of connecting TCB is to use jumpers at the instrument terminals as shown in Fig. 2. As the length of lead wire used affects the amount of TCB compensation required, it is suggested that this method be used with short lead wire lengths, 10 ft. or less and that the amount of TCB error be checked.

To check for TCB operation, disconnect the thermocouple to simulate a broken thermocouple but leave the TCB wires connected to the lead wire. When the instrument is powered, the indicator should drive upscale above the red control set pointer to cause the control to go to the off position.

TCB is not effective on Heat Eye (radiation head) calibrations because of the compensating network in the Heat Eye.

METER ADJUSTMENTS AND CHECK

After the instrument is mounted, check for the cold junction reading of the meter. Disconnect the lead wire at the instrument. The indicator should come to rest at the ambient temperature of the meter; it is NOT supposed to read zero. Place a thermometer at the TC instrument terminals to read ambient temperature.

If the pointer does not come to rest at the ambient temperature, slowly adjust the screw located on top of the front plastic cover. As the meter has automatic cold junction compensation, it is not necessary to make further corrections as the ambient temperature changes.

To check for thermocouple break error (TCB) if it is connected, it is best to have a steady temperature at the hot junction of the thermocouple. Read the temperature at the indicator. For exact reading, position the eye so the reflected image of the pointer on the mirrored strip disappears behind the pointer itself. This reading to be made with power on the instrument. Then disconnect power to the instrument, remove the control chassis, or disconnect the wires at the TCB terminals and note if the indicated temperature drops. Reconnect to see if temperature rises. If a shift in reading is noticed, usually a small amount if any, adjust the screw on the top of the plastic cover, so the reading with TCB powered is at the same point as read with TCB disconnected. If an adjustment was made, the ambient temperature reading will also shift a like amount.

CONTROL SPECIFICATIONS MODEL 403C

The Model 403C is primarily a three position indicating controller which has two S.P.D.T. switches that can be wired to cause a control action to occur at two different points on the scale. The operating point of the low point control switch occurs at coincision of the meter indicator and the red control pointer. The operating point of the high point control switch is adjustable from approximately ½% to 5% of full scale above the low point. Signal lights indicate the points at which the two control actions occur.

The contacts of the control switches are rated at 5 amperes for 120 volts and 2½ amperes for 240 volts for use with non-inductive loads such as electric heaters and lights. Decrease these ratings 50% for inductive loads such as relay coils and transformers.

The control point setting knob is located directly below the instrument scale and is easily adjusted. Both control points move when the knob is turned but their relationship remains the same.

The control chassis includes a "Capaciline" circuit on the low control point used to minimize over and undershooting at the set point. It is a form of proportioning which will move the indicating pointer upscale slightly ahead of the normal upscale deflection or downscale slightly ahead of the normal downscale deflection. Changes are thus "anticipated", causing a faster ON-OFF control action and more nearly straight-line control.

DESCRIPTION OF ELECTRONIC CIRCUIT

The Model 403C is a development of the original "Electronic Link". A small vane or flag on the indicating pointer passes between two flat coils mounted on the control set pointer. The output of an oscillating circuit varies, depending on the position of the vane in the coils, and is fed to the relays to cause a control action to occur. Jacks are provided to facilitate checking the voltage across the relays.

OPERATION

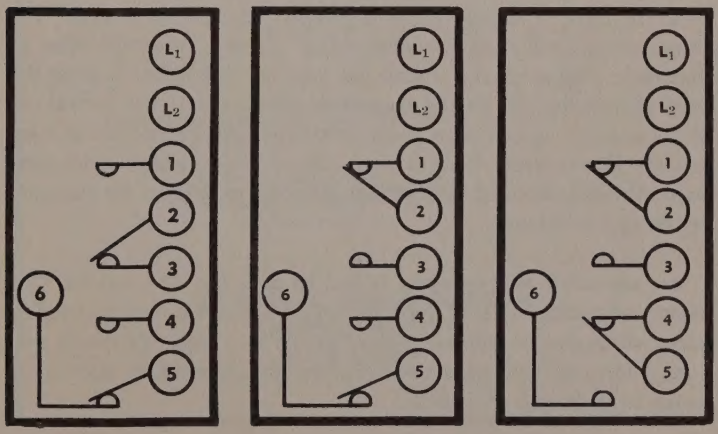
The low point switch is connected to terminals 1, 2, 3 and the high point switch to terminals 4, 5, 6. Terminals 2 and 5 are common with 1 made to 2, and 4 made to 5 when the relay is not energized. The right hand signal light on the instrument indicates when the low point switch is actuated and the left hand signal light indicates actuation of the high point switch. In addition to the signal light, the red control set pointer also indicates the point at which the low point switch actuates. When the instrument is powered, the following switch positions occur, depending on the position of the meter indicator: (Allow 30 seconds for the instrument to warm-up after powering).

NOTES:

(1) Control action shown with instrument powered.

(2) The lower control setting is connected to terminals 1, 2 and 3.

(3) The higher control setting is connected to terminals 4, 5 and 6.



BELOW CONTROL POINTS
Left (Red) light ON
Right (Green) light OFF

BETWEEN CONTROL POINTS
Both lights ON

ABOVE CONTROL POINTS
Left (Red) light OFF
Right (Green) light ON

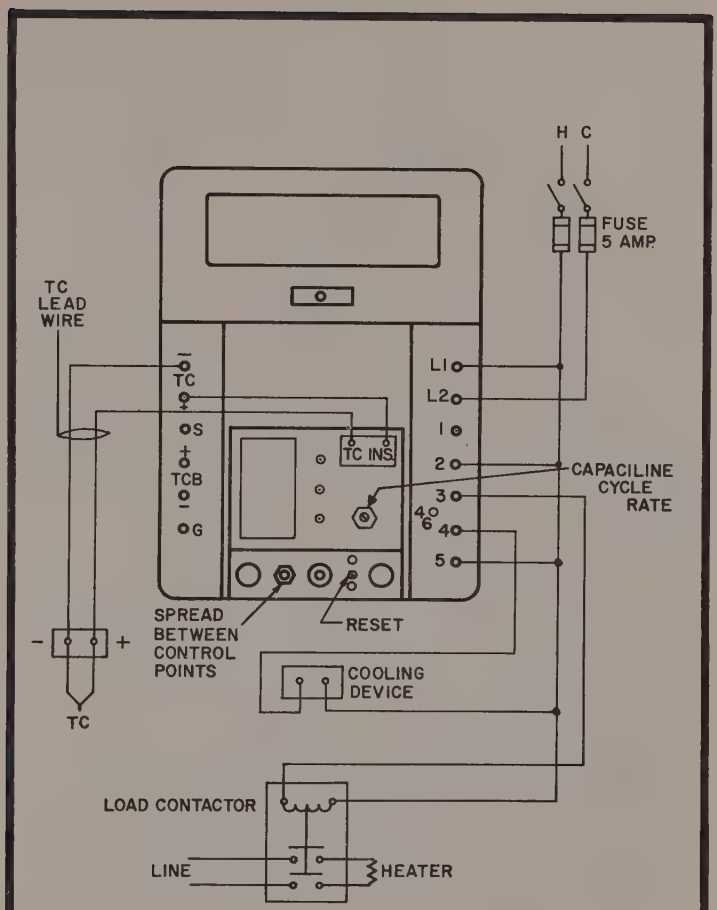
CONTROL ADJUSTMENTS

Located on the front of the control chassis are three adjustments. The left-hand adjustment changes the point at which the high or upper switch actuates with respect to the low switch. Turn to the left or counterclockwise for a narrow spread between the two switches, minimum approximately ½ of 1% of scale range. Turn to the right or clockwise to increase the spread of operation between the two switches, maximum approximately 5% of scale range. It is suggested to set this control at maximum when making alignment adjustment.

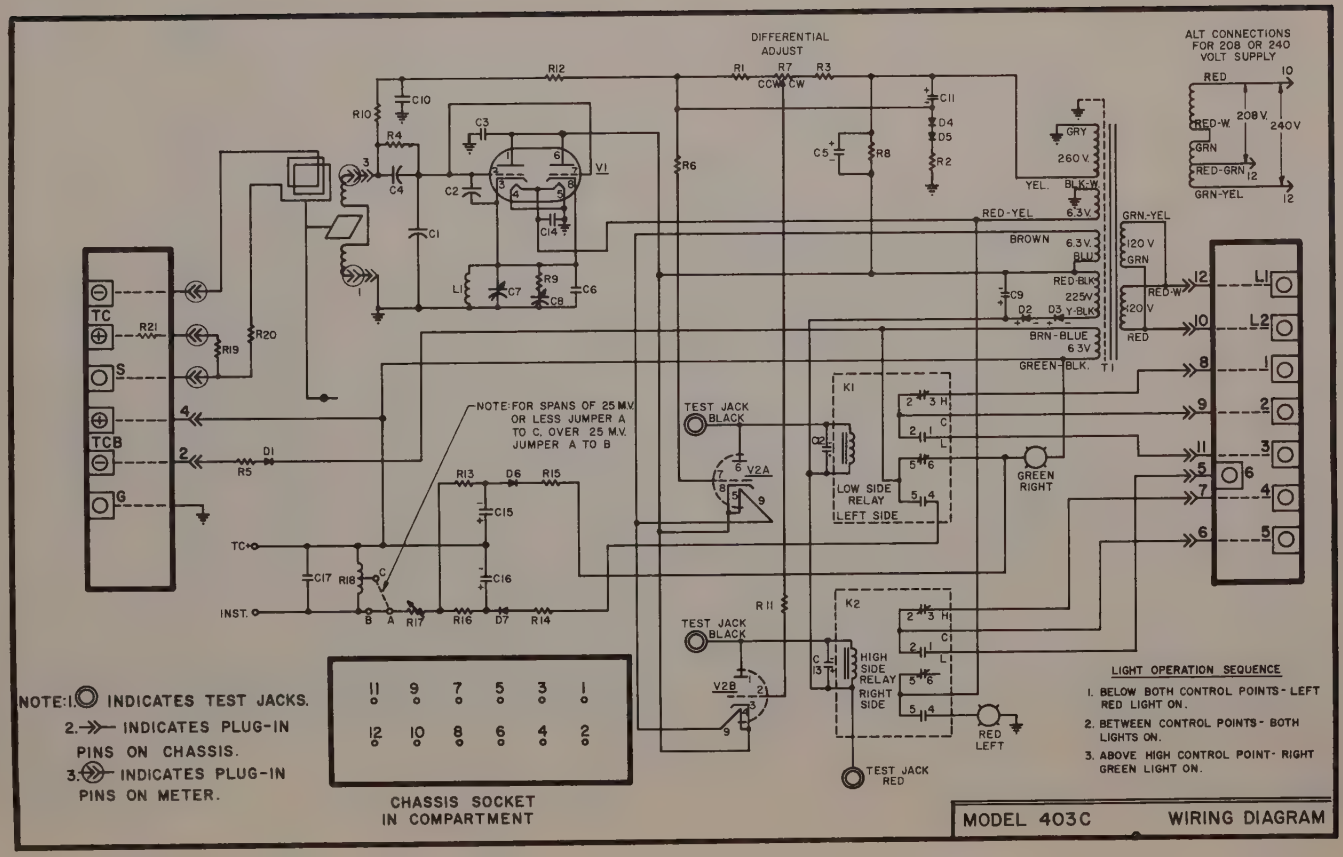
The right-hand adjustment, or "RESET", is used to align the point of operation of the low point relay and the red control set point index. The low point relay (right-hand signal light) should actuate as the meter indicator crosses the red control index. To tune the control, first bring the pointers together. Then, starting from the clockwise limit, adjust RESET counterclockwise slowly until control action turns ON, and right hand signal light turns OFF. Recheck by moving red control pointer across the black pointer.

The Capaciline effect or rate of cycling can be adjusted by a rheostat located on the front of the chassis marked CYCLE RATE. Turn CW or to the right to increase Capaciline action or CCW to decrease. For initial setting, adjust for minimum effect. Allow a reasonable time to determine how much the control has been affected before making the next adjustment. While the Capaciline adjustment is not critical, an over correction as well as an under correction may cause deviation from straight line control. Favor a slow rate to avoid excessive contactor wear. Properly adjusted, it is seldom necessary to readjust for changing operating conditions.

An adjustable slug capacitor is located near the tube sockets. The factory adjustment is .006" for ON-OFF of each relay (usually satisfactory) which may be widened (clockwise) or vice versa. Extremely narrow differential may cause relay chatter. This adjustment also effects range of cycle rate adjustment.



EXTERNAL WIRING DIAGRAM
MODEL 403C
HEATING AND
OVER-TEMPERATURE COOLING


DIFFERENTIAL ADJUST
CCW CW
ALT CONNECTIONS FOR 208 OR 240 VOLT SUPPLY
RED
RED-W.
GRN
RED-GRN
GRN-YEL
208 V.
240V
TC
TCB
S
G
INST.
NOTE: FOR SPANS OF 25 M.V. OR LESS JUMPER A TO C. OVER 25 M.V. JUMPER A TO B
TEST JACK BLACK
TEST JACK RED
LOW SIDE RELAY LEFT SIDE
HIGH SIDE RELAY RIGHT SIDE
GREEN RIGHT
RED LEFT
260 V.
6.3V.
225V
120 V
GRN-YEL
RED-YEL
BROWN
BLU
RED-BLK
Y-BLK
BRN-BLUE
GREEN-BLK.
YEL.
BLK-W
GRY
T1
L1
L2
CHASSIS SOCKET IN COMPARTMENT
11 9 7 5 3 1
12 10 8 6 4 2
NOTE: 1. INDICATES TEST JACKS.
2. INDICATES PLUG-IN PINS ON CHASSIS.
3. INDICATES PLUG-IN PINS ON METER.
LIGHT OPERATION SEQUENCE
1. BELOW BOTH CONTROL POINTS - LEFT RED LIGHT ON.
2. BETWEEN CONTROL POINTS - BOTH LIGHTS ON.
3. ABOVE HIGH CONTROL POINT - RIGHT GREEN LIGHT ON.
MODEL 403C WIRING DIAGRAM

PARTS LIST

ITEM	DESCRIPTION	PART NO.
C1	12 MMF 500 V.D.C.W. ±5%	39-107
C2	30 MMF 600 V.D.C.W. ± 5%	39-067
C3	.005 MFD 500 W.V.A.C.	39-172
C4	.02 MFD 600 V.D.C.W. G.M.V.	39-062
C5	8 MFD 250 V.D.C.W.	CYZR-327-1
C6	62 MMF 600 V.D.C.W. ± 10%	39-087
C7	8-50 MMF Variable	39-105
C8	1-8 MMFD Tubular Trimmer	39-111
C9	4 MFD 450 V.D.C.W.	39-027-1
C10	.002 MFD 600 W.V.D.C. ± 10%	39-100
C11	4 MFD 450 V.D.C.W.	39-027-1
C12	8 MFD 250 V.D.C.W.	CYZR-327-1
C13	8 MFD 250 V.D.C.W.	CYZR-327-1
C14	.005 MFD 500 W.V.A.C.	39-172
C15	100 MMF 12 V.D.C.W. ± 10%	39-092
C16	100 MMF 12 V.D.C.W. ± 10%	39-092
C17	.005 M.F. 600 V.D.C.W. ± 10%	39-172
R1	1.5 K ± 10% ½ W	CYZR-133-2
R2	15 K ± 10% ½ W	CYZR-170-45
R3	33 K ± 10% ½ W	40-082
R4	150 K ± 10% ½ W	CYZR-170-37
R5	27 K ± 10% ½ W	CYZR-170-7
R6	470 K ± 10% ½ W	CYZR-170-13
R7	0-50 K Variable ½ W Linear Taper	29-042-1
R8	35 K ± 10% 3 W	40-164
R9	560 ± 10% ½ W	CYZR-170-52
R10	8.2 Meg. ± 10% ½ W	40-089
R11	470 K ± 10% ½ W	CYZR-170-13
R12	8.2 Meg. ± 10% ½ W	40-089
R13	1.5 K ± 10% ½ W	CYZR-133-2
R14	1.5 K ± 10% ½ W	CYZR-133-2
R15	47 K ± 10% ½ W	40-070-2
R16	47 K ± 10% ½ W	40-070-2
R17	0-250 K Var. ½ W. Lin. Taper	BYZR-38
R18	10 Ohm W.W. Center Tap Spool	A-3633
R19	Multiplier Spool (Specify Type and Range)	A-1847
R20	Temp. Comp. Res. Assm.	A-3049-1
R21	Ext. Res. Comp. Resistor	A-3497
D1	Silicon Diode	37-030
D2	Silicon Diode	37-026
D3	Silicon Diode	37-026
D4	Silicon Diode	37-026
D5	Silicon Diode	37-026
D6	Silicon Diode	37-030
D7	Silicon Diode	37-030
L1	Oscillator Coil	41-120-1
K1	Relay	A-4098
K2	Relay	A-4098
T1	Transformer	30-070-1
V1	Vacuum Tube (12AU7)	EYZP-70-9
V2	Vacuum Tube (12AU7)	EYZP-70-9

METER MAINTENANCE AND SERVICING

While the 400 Series instrument is well designed and manufactured of high grade components, it is worthwhile to have information for emergency servicing. Where a number of instruments are located in the same area, many parts are interchangeable and allows a minimum inventory.

In event of trouble, the serviceman should familiarize himself with the process and instrument application to ascertain the exact function of the instrument as applied. The trouble usually can be traced to two basic problems, measurement or control.

If the measured temperature is known to be in error, check the following:

(1) Open thermocouple circuit, such as break in thermocouple or lead wiring.

(2) Deteriorated T. C. hot junction due to burning.

(3) Shorted, grounded, or damp lead wire or thermocouple except the thermocouple hot junction may be grounded.

(4) Correct polarity of lead wire and thermocouple.

(5) Check for vibration or shock.

(6) A calibration check for meter accuracy can be made with a Portable Model 330P or equivalent.

(7) Do not oil or grease any part of the instrument.

In event it is found necessary to remove the plug-in meter assembly, follow these steps:

(A) Remove control set point knob (Bristol #6 wrench).

(B) Remove the four cover screws.

(C) Remove cover straight forward to prevent damage to internal meter parts.

(D) Loosen the two screws in lower meter chassis corners.

(E) Insert fingers behind the two lugs and pull forward carefully to avoid sudden jarring.

(F) Place a jumper wire across the prongs on the back of the meter to dampen the movement.

(G) Position the red pointer to top of scale.

(H) As the meter is exposed, avoid dirt and metal chips.

Reassembly is of reverse procedure, being careful to line up the slotted lever for the zero adjustment pin when replacing the meter cover. Recheck for ambient temperature setting as previously described.

CONTROL MAINTENANCE AND SERVICING

If the control does not function properly and the temperature does not stay at the control point, check the following:

(1) Check power to the instrument. Should be 110 to 130 volts AC or 220 to 260 volts AC depending on chassis specifications.

(2) Replace electronic tubes. Three jacks on the front of the control chassis are provided to read voltage across the relay coils. The center and left-hand jacks check voltage of low point relay and the center and right-hand jacks check the high point relay. With the red control index well above the indicator, the DC voltage should read between 90 to 145 volts. When the red index is below the indicator, the reading should be 15 volts or less. The same readings apply to both coils.

(3) Relay limits can be checked by moving the red control index slowly across the indicator. Relay pull-in voltage is 60 to 80 volts DC, drop-out is 30 to 50 volts DC. These readings can be noted as the signal lights operate.

(4) Replace chassis. Take advantage of the interchangeable plug-in components if other instruments of the same type and voltage are available.

(5) Check external circuit for sticking valves or contactors, fuses, grounded or shorted wiring, etc.

(6) To alter the control chassis in the field for a different line voltage, change the transformer primary connections per the following: (Also see internal wiring diagram)

240 volt:
Red to pin 10 (L2)
Green-Yellow to pin 12 (L1)
Connect Red-White to Green and tape

208 volt:
Same as 240 volt except
Green-Red to pin 12 (L1)
in place of Green-Yellow

120 volt:
Red and Green to pin 10 (L2)
Red-White and Green-Yellow to pin 12 (L1)

(7) Tube number 5814 can be used in place of EYZP 70-9 (12AU7) if desired, but equivalent for EYZP 70-15 (12AV7) is not available.

(8) Pilot or signal lights are #1908, #51 or #47 Mazda bulbs.

(9) Connect a grounding wire to the "G" terminal if the instrument is ungrounded.

SUGGESTED REPLACEMENT PARTS

It is suggested that a few spare parts be carried by the user to insure against possible emergencies and accidental damage. These are listed in the order of probable relative need:

	Part No.
*Electronic Tube 12AU7 — Front or rear	EYZP 70-9
12AV7 — Rear only (optional)	EYZP 70-15
Thermocouple	
Mazda pilot lamps	36-022-1
Chassis complete with 12AU7 and 12AV7 tubes for	
120 V/60C	A-5471
208 V/60C	A-5472
240 V/60C	A-5473

*NOTE: We recommend purchase of the 12AU7 and 12AV7 tubes from the Industrial Instruments Division, Barber-Colman Company, to insure instrument functioning as designed. Tube 5814 can also be supplied to replace the 12AU7.

THERMOCOUPLES

To help you select the best thermocouples for any of your needs, two comprehensive catalogs are available to you without charge. Write to the factory or call your nearest representative.

- - For general purpose thermocouples, request Data Book and Catalog TC-13A.

- - For thermocouples used primarily in the Plastics Industry, request Catalog TC-13B.

MATERIAL WARRANTY: All equipment except tubes, photocells, and thermocouples, which within one year from date of shipment is found to have been originally defective, will be repaired (replaced if necessary) free of charge, if returned immediately, prepaid to the factory at Rockford, Illinois. The seller shall not be liable to the purchaser, or to any other person, firm or corporation for any direct, indirect or consequential damages or injury of any kind or character; that by acceptance of such equipment the purchaser shall accept and assume all liability for any and all damages or injuries that may result from the use or misuse of such equipment by the purchaser, or by any other person, firm or corporation; and that there shall be no other warranty whatever, expressed or implied, with respect to such equipment.

Fill out this copy for your records from the Warranty Card found in the shipping carton. Should original be mislaid before returning, please supply the required information on a post card and mail to:

BARBER-COLMAN COMPANY
Industrial Instruments Division
Rockford, Illinois

Warranty and Inspection Card

This equipment is guaranteed in accordance with the statement of warranty appearing on our quotation and acknowledgement forms. Upon receipt of this card properly filled out Warranty becomes effective. All Barber-Colman instruments are manufactured to the highest standards of quality and are carefully inspected before packing. Instruments which have been damaged or fail to operate upon installation, should be reported to the Factory at once.

BARBER-COLMAN COMPANY
Industrial Instruments Division

MODEL NO.	Date Received		
	Company		
SERIAL NO.	Street		
	City	Zone	State
CALIBRATION INSP.	By		Title
	COMMEN		
FINAL INSPECTION			

COPY

MP MASTER
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